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Lung Cancer Screening in the National Cancer Institute Community Oncology Research Program: Availability and Service Organization

Ruth C. Carlos, MD, MS, FACR[1,2], **JoRean D. Sicks, MS**[3], **Caroline Chiles, MD**[4], **Lucy Gansauer, MSN, RN**[5], **Charles S. Kamen, PhD, MPH**[6], **Anne E. Kazak, PhD, ABPP**[7], **Heather B. Neuman, MD, MS, FACS**[8], **Joseph M. Unger, PhD, MS**[9], **Kathryn E. Weaver, PhD, MPH**[10]

[1]Department of Radiology, University of Michigan Health System, 1500 E. Medical Center Drive, Ann Arbor, MI 48109-0030

[2]Institute for Healthcare Policy and Innovation, University of Michigan, 2800 Plymouth Road, North Campus Research Complex, Building 16, Ann Arbor, MI 48109

[3]ECOG-ACRIN Biostatistics and Data Management Center, Brown University Center for Statistical Sciences, 121 South Main Street, Providence, RI 02912

[4]Department of Radiology, Wake Forest University Health Sciences Center, Medical Center Boulevard, Winston-Salem, NC 27157

[5]Spartanburg Medical Center, 101 E. Wood St., Spartanburg, SC 29303

[6]Cancer Control Unit; University of Rochester, 601 Elmwood Ave, Rochester, New York 14642

[7]Nemours Center for Healthcare Delivery Science, Nemours Children's Health System, 1600 Rockland Rd, Wilmington, DE 19803

[8]Department of Surgery, University of Wisconsin, 600 Highland Ave, Madison, Wisconsin 53792

[9]SWOG Statistics and Data Management Center, Public Health Sciences, Fred Hutchinson Cancer Research Center, Seattle, WA 98109

[10]Department of Social Sciences and Health Policy, Wake Forest University School of Medicine, Medical Center Boulevard, Winston-Salem, NC 27157-0001

Corresponding author: Ruth C. Carlos, rcarlos@med.umich.edu.

AUTHOR CONTRIBUTIONS:
1 Conceptualization: RCC, CC
2 Data Curation: KEW, JDS, RCC
3 Formal analysis: JDS
4 Funding acquisition: N/A
5 Investigation: KEW
6 Methodology: RCC, LG, CSK, AEK, HBN, JMU, KEW (equal)
7 Project administration: KEW
8 Resources: KEW
9 Software: N/A
10 Leadership: KEW, RCC
11 Validation: N/A
12 Visualization: RCC, JDS
13 Writing—Original Draft: RCC, JDS
14 Writing—Review and Editing: RCC, JDS, LG, CC, CSK, AEK, HBN, JMU, KEW (equal)

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Abstract

Background: Annual low dose CT (LDCT) for lung screening in high-risk individuals decreases both lung cancer-specific mortality and all-cause mortality. Community oncology practice networks comprising the NCI Community Oncology Research Program (NCORP) conduct clinical trials across the cancer spectrum. We report access to and characteristics of LDCT screening for lung cancer in these community oncology practices.

Methods: A Landscape Capacity Assessment was conducted in 2017 across the NCORP network. The primary outcome was the proportion of adult oncology practice groups offering LDCT lung screening onsite. The secondary outcomes were the proportion of those screening services 1) with radiologist participation in service management and 2) offered in American College of Radiology (ACR) Designated Lung Cancer Screening Centers.

Results: 53% of components/subcomponents responded to at least some portion of the assessment, representing 217 practice groups. Analyzing the 211 adult oncology practice groups responding to the primary question, 73% offered lung screening services onsite. Radiologists participated in managing 69% of these services. 47% were offered in ACR Designated Lung Cancer Screening Centers. Minority and underserved practice groups were less likely to offer lung screening; however, this association dissipated when analyses focused on practices within the United States. Safety net and Critical Access Hospital designation increased the likelihood of screening availability.

Conclusion: The majority of community oncology practice groups within the NCORP offered lung screening onsite, although radiologist participation in service management and ACR Lung Cancer Screening Center designation, markers of service quality, were more variable.

Summary statement:

The majority of community oncology practice groups within the NCORP offered lung screening onsite, although radiologist participation in service management and ACR Lung Cancer Screening Center designation, markers of service quality, were more variable.

Introduction:

Lung cancer screening by low dose CT (LDCT) effectively decreases both lung cancer-specific mortality and all-cause mortality[1,2] of this leading cause of cancer deaths[3]. This mortality benefit underscores the importance of rapid diffusion of lung cancer screening to practice, including community oncology practices where 77% of cancer patients receive their care[4]. The number of screening sites has increased rapidly from 203 in 2014[5] to 2423 in 2017[6]. Eberth's 2014 analysis noted gaps in LDCT screening availability in several high risk states[5]. While data from our group indicate reasonable match between screening facilities and populations at risk, screening sites are not evenly distributed, increasing the potential for geographic disparities[6].

The NCI Community Oncology Research Program (NCORP)[7] is composed of 34 community sites and 12 minority/underserved sites. NCORP defines a community site as a consortium of community hospitals and/or oncology practices or a community-based integrated healthcare system. NCORP sites are located in the United States and Puerto Rico.

A minority/underserved (MU) community site is defined as a consortium of community hospitals and/or oncology practices, a public hospital, or academic medical center that has a patient population with at least 30% racial/ethnic minorities or rural residents[7]. Sites in the United States represent both community and MU sites while the single site in Puerto Rico is an MU site. This broad network includes independent community practices, system-affiliated practices and safety-net institutions making NCORP a unique research setting to evaluate multilevel organizational structures and contextual factors influencing the process and outcome of cancer care[8]. Tasked with conducting clinical trials across the cancer spectrum from prevention to diagnosis, these community oncology sites serve as key providers of screening services. However, LDCT lung cancer screening service availability in this setting, as well as quality indicators of the screening service, may lag need and potentially contribute to disparities to access. This service disparity may be intensified by potential differences in lung screening coverage and public health prioritization in the United States compared to Puerto Rico. We aim to assess the availability of lung cancer screening within the NCORP and quality indicators of this screening service, including designation as an American College of Radiology Designated Lung Cancer Screening Center, participation in a lung screening registry and radiologist involvement in the management of service delivery.

Methods:

Survey population:

The 46 NCORP sites, community sites (n=34) and minority and underserved community sites (n=12) consisting of 943 components and subcomponents were identified[7]. NCORP sites are located in the United States and Puerto Rico. These community and MU community sites include components, defined as a hospital, cancer center, physician practice, or other institution where patients/participants are enrolled on NCI-approved clinical trials open to the NCORP. Subcomponents are defined as a practice or organization that contributes to the overall accrual of a component but is located in a separate geographic location, is part of the component's business entity, and is managed by the component[7]. All components and subcomponents were eligible to complete the 2017 Landscape Assessment, but only 650 indicated an interest in participating. Practices that identified themselves as solely children's oncology practices, i.e. children's hospital with pediatric inpatient beds and no adult inpatient beds, were excluded from this analysis.

Survey design:

Designed to evaluate the capacity within NCORP to conduct cancer care delivery research, the initial Landscape Assessment was fielded in 2015. A second Landscape Assessment, similarly designed by a multidisciplinary committee assembled by the NCI's Division of Cancer Prevention queried institutional characteristics (e.g. organizational ownership, practice size); clinical staff characteristics and capacity to provide diagnostic, therapeutic and supportive oncologic services (e.g. lung cancer screening, genetic testing, or nutritional counseling). This latter survey was fielded by Wake Forest Research Base in 2017 using the same methods previously described[9]. Briefly, principal investigators at each of the NCORP sites identified points-of-contact (POCs) at each component and subcomponent responsible

for survey completion. Multiple components or subcomponents could be designated as a single operational practice unit or "practice group" sharing common care practices and resources. Using practice grouping patterns identified in the responders, non-responding components and subcomponents were manually assigned into similar practice groupings; however the large majority (71%) of practice groups did represent a single component or subcomponent.

Survey analysis:

The primary outcome was the proportion of adult oncology practices that offered onsite low dose CT screening (LDCT) for lung cancer. Secondary outcomes assessed were the proportion of lung screening services that 1) involved a radiologist in service management, and 2) were offered in an American College of Radiology (ACR) Designated Lung Cancer Screening Center. Independent correlates of the primary and secondary outcomes included organizational characteristics such as minority and underserved community site designation, practice size and ownership.

For the primary and secondary outcomes, "don't know" and "no" responses were grouped together. For the primary outcome, practices with non-responses (n=6) were excluded from further analyses. For any other variables missing data including the secondary outcomes and any predictor variables, missing at random was assumed and a complete case analysis was performed. Logistic regression was used to assess the impact of practice characteristics on the primary and secondary outcomes. A multivariate model was performed including all variables significant in bivariate models. Backward variable selection was performed to obtain a parsimonious multivariate model. Variables were removed until the remaining variables were significant at $P<0.05$. Organization type, estimated number of adult beds, number of oncology physicians were included as class variables with 3 degrees of freedom each.

Given differences in health insurance coverage and the emphasis on lung cancer prevention rather than screening[10], the above analyses were replicated in a subpopulation of NCORP practices within the 50 US states, excluding Puerto Rico.

All analyses were conducted using SAS (SAS Institute, Cary, North Carolina).

Results:

Of the 943 NCORP components and subcomponents, 493 (52%) responded to at least some of the survey, representing 217 practice groups. Of the 650 components and subcomponents that expressed interest in participating, 76% responded to at least some of the survey. Of these, 6 did not respond to the primary outcome and were excluded from subsequent analyses, leaving 211 evaluable adult oncology practices.

Adult oncology practice characteristics:

Of the responding practices, 17.1% were affiliated with minority or underserved sites, 24.4% self-identified as safety net hospitals and 21.5% were affiliated with a designated Critical Access Hospital. 55.5% were owned by a large regional or multi-state health system while

34.4% claimed independent ownership. The median number of oncologists at each practice was 9 (range 0–203).

Capacity for onsite LDCT lung cancer screening:

A majority of the oncology practices (73.0%) offered onsite LDCT for lung cancer screening (Table 1). Of these services, 47.4% were designated as an American College of Radiology (ACR) Lung Cancer Screening Center and 69.5% had radiologist involvement in lung cancer screening service management. Radiologists solely managed 34 (22%) services and participated in a multidisciplinary management in 73 (47%) services.

Of the 154 practices offering screening services onsite, 98 (63.6%) participated in the American College of Radiology (ACR) Lung Cancer Screening Registry (LCSR), the only registry approved by Centers for Medicare and Medicaid Services (CMS) for Medicare reimbursement[11]. Screening practices also participated in other registries, including the International Early Lung Cancer Action Program (I-ELCAP) Registry[12], 3 (1.9%); their own institutional registry, 25 (16.2%) or other registries, 11 (7.1%). 29 (18.8%) did not indicate any registry participation.

Table 2 summarizes the bivariate analyses. In multivariate analyses, minority and underserved designation remained a significant negative correlate of onsite lung screening availability (adjusted OR 0.34, 95%CI 0.12–0.94) while safety-net hospital self-identification (adjusted OR 3.22, 95%CI 1.02–10.19) and Critical Access Hospital affiliation (adjusted OR 3.49, 95%CI 1.11–10.95) were independently associated with increased likelihood of screening availability (Table 3). As a group, HMO-, public- or university-ownership decreased the likelihood of screening availability (adjusted OR 0.12, 95% CI 0.02–0.52) compared to independent ownership. Having adult inpatient facilities, regardless of the number of inpatient beds, increased the likelihood of onsite service availability, as did having 23 or more oncology physicians.

Regarding the management of lung cancer screening services offered, adjusting for other predictors, services offered in minority and underserved practices were less likely to have radiologists participating in the screening service management (adjusted OR 0.37, 95% CI 0.16–0.86);organizational ownership type and number of oncologists within the practice were not associated.

No organizational characteristics evaluated were associated with the likelihood of designation as an ACR Lung Cancer Screening Center.

Subanalyses excluding Puerto Rico

None of the practices in Puerto Rico (n=7) offered lung cancer screening. Limiting the analyses to practices within the United States, excluding Puerto Rico, 73.3% offered lung cancer screening onsite. In this subanalysis, minority/underserved designation was no longer a significant predictor. Multivariate predictors of lung cancer screening availability included classification as a safety net hospital (OR= 3.26, 95% CI=1.02–10.48), affiliation with a critical access hospital (OR= 3.31, 95% CI=1.07–10.20), ownership by large regional/multi-state health system with a health plan (OR= 2.89, 95% CI=1.05–8.01), having an inpatient

service regardless of number of beds and having 23 or more oncology physician onsite (Table 4). Regarding the management of lung cancer screening services offered, adjusting for other predictors, affiliation with critical access hospital decreased the likelihood of radiologist involvement in the screening management (OR= 0.39, 95% CI= 0.18–0.84). As in the main analyses, no organizational characteristics evaluated were associated with the likelihood of providing the service in an ACR Designated Lung Cancer Screening Center.

Discussion:

Lung cancer screening was available at the majority of the community oncology practices within NCORP. Approximately half of screening services were offered in an ACR Designated Lung Cancer Screening Center. Minority and underserved sites were less likely to offer lung cancer screening; however, there were no differences between community sites and minority and underserved sites when focusing on US community oncology sites only, without Puerto Rico. Safety net hospitals and those affiliated with a critical access hospital were more likely to offer lung cancer screening services. Almost 70% of lung cancer screening services involved radiologist management, either solely, or as part of a multidisciplinary team. More than half of the practices, offering lung cancer screening, participated in the American College of Radiology (ACR) Lung Cancer Screening Registry (LCSR), the only CMS approved registry. The ACR LCSR is actively addressing the information technology barriers to participating in the registry. Minority and underserved practices offering LDCT lung screening were less likely to have radiologist involvement in screening service management.

Access to lung cancer screening has markedly increased since 2014 when Eberth et al identified 203 lung cancer screening service providers across the US[5]. More recent evaluation by Charkhchi et al found 2423 screening service providers[6]. This increase in availability has been bolstered by the United States Preventive Services Task Force Grade B recommendation for screening among 55–80 year olds with at least 30 pack year smoking history[13] and Affordable Care Act elimination of cost-sharing[14].

Community oncology practices are critical providers of care across the cancer spectrum, particularly minority and underserved sites that comprise at least 30% racial and ethnic minorities or rural residents. Early experience in lung cancer screening implementation have noted several system-level barriers: inadequate time for consulting, inadequate staffing and patients having too many other co-morbidities to address screening[15], workload management to ensure appropriate evaluation of pulmonary nodules detected by screening[16], difficulty in identifying screening-eligible patients, limited resources to support screening and information technology including reporting to the CMS-approved registry[17]. As LDCT lung screening guidelines and reimbursement have matured, its availability has increased in the broad community. Within the NCORP, three-fourths of responding practices offered LDCT lung screening onsite, suggesting that NCORP may be an ideal network to conduct research to improve screening uptake and enhance implementation. For example, a current NCORP site-randomized trial is testing an intervention to improve delivery of evidence-based tobacco cessation at the point of care for LDCT.

Our initial analyses of minority and underserved oncology practices noted decreased likelihood of offering LDCT lung screening compared to other community oncology practices. The practices represented were located in the US and Puerto Rico. We identified seven practices in the Puerto Rico, all minority/underserved practices; none offered lung cancer screening. There is controversy regarding differences of quality and access of health care services between Puerto Rico and US. Rivera-Hernandez et al. compared quality of preventive care, including breast and colon cancer screening, provided to white and Hispanic Medicare Advantage (MA) enrollees in the United States and Puerto Rico. They found significantly worse care for enrollees in Puerto Rico compared with their US counterparts[18]. Other studies support the presence of a gap between healthcare services in Puerto Rico and the US[19] such as lower colonoscopy rates[20]. However, Portela et al. reported screening rates for mammograms and Pap smears were comparable or better in Puerto Rico than US[20]. Regarding lung cancer screening, lack of insurance coverage represented the most common limitation for implementation followed by inadequate infrastructure and lack of radiologist support[21]. Further, the Puerto Rico Comprehensive Cancer Control Plan: 2015–2020 focuses on lung cancer management through smoking cessation and risk reduction rather than screening, dissimilar from the proposed approach to breast, cervical and colon cancer[10]. Therefore, we conducted subanalyses excluding the Puerto Rico practices. In these subanalyses, no significant differences in lung cancer screening availability were detected between minority and underserved practices compared to other community oncology practices with the US.

We found that practices owned by large regional/multi-state health systems with or without a health plan, having inpatient adult facilities, or having 12 or more oncology physicians were more likely to offer lung cancer screening. In a review of the effect of organizational structure on cancer screening process, Anhang Price et al. found mixed evidence for the relationship between patient volume (as a measure of practice size) and cancer screening adherence[22–26]. They highlighted that availability of facilities and staff for screening are necessary, but insufficient in the absence of other important factors such as promoting patient recruitment, provider recommendation, and patient–provider communication[26]. In our population, we posit that larger practices delivering a variety of care services have more human and technology resources, potentially facilitating the implementation of lung screening in these practices.

Implementation of lung cancer screening would increase imaging procedures by an average of 4% across health service areas[27]. Smieliauskas et al reported that health service areas which were rural, with many eligible smokers, and disproportionately Hispanic or low-income smokers had significantly higher odds of facing capacity limitations[27]. In our evaluation, lung screening services offered in minority and underserved practices were less likely to have radiologists participate in the service management. It remains to be seen if radiologist participation in screening program management results in enhanced capacity and service utilization.

Our study has notable limitations. This assessment was conducted as an internal assessment or research capacity, thus we had limited information about LDCT screening services and potential predictors. We assumed that all practice locations within a given practice group

offered the same lung screening service. We assessed lung cancer screening availability, not actual utilization; however, demonstrating resource availability is a necessary component of successful screening implementation and supports the feasibility of conducting LDCT screening research within the NCORP network.

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Take Home Points:

1. The NCI Community Oncology Research Program, a consortium of community practices that deliver oncologic care, represents one of the ideal networks to understand the dissemination and implementation of lung cancer screening.
2. The majority of these community oncology practices offered lung cancer screening onsite although only half of the screening services took place in an ACR Designated Lung Cancer Screening Center.
3. Minority and underserved sites were less likely to offer lung screening, while safety net hospitals and those affiliated with critical access hospitals had higher availability.
4. Radiologists participated in the implementation and management of lung screening in 70% of practices.
5. Availability of service does not guarantee use; radiologist participation in service management may improve patient participation.

Implications:

A large proportion of NCORP community sites offered lung cancer screening services onsite. Minority and underserved oncology practices located in the United States were as likely to offer this service as other community oncology practices. Larger practices with inpatient facilities were also more likely to offer LDCT services onsite. Availability alone does not guarantee use. Radiologist participation in implementation and management may improve patient participation where lung screening services are available.

Table 1:

Proportion of NCORP adult oncology practices offering low dose CT (LDCT) for lung cancer screening onsite and characteristics of these screening services.

	N	Denominator[1]	%
Lung cancer screening offered	154	211	72.99
Radiologist involved in lung cancer screening service management	107	154	69.48
Service is an American College of Radiology Designated Lung Cancer Screening Center	73	154	47.40

[1]Denominators exclude those practices (n=6) that did not respond to the item querying onsite availability of LDCT lung screening

Table 2.

Correlates of onsite availability of low dose CT (LDCT) for lung cancer screening, radiologist involvement in lung screening service management and service designation as the American College of Radiology Designated Lung Cancer Screening Center, under bivariate analyses.

Organizational characteristics	N[2]	%	LDCT for lung cancer screening onsite available OR (95% CI)	Radiologist involvement in service management OR (95% CI)	ACR Designated Lung Cancer Screening Center OR (95% CI)
NCORP Minority or underserved site (n[1]=211)	36	17.06	0.33 (0.16–0.70)	0.92(0.33–2.60)	0.76(0.28–2.01)
Primarily a safety-net hospital (n=209)	51	24.40	2.91 (1.23–6.91)	1.02(0.47–2.19)	1.40(0.69–2.83)
Affiliated with a designated Critical Access Hospital (n=209)	45	21.53	3.71 (1.39–9.95)	0.39(0.18–0.84)	1.87(0.90–3.90)
Organizational ownership (n=209)					
Independently owned	72	34.45	REF	REF	REF
Owned by large regional/multi-state health system with a health plan	80	38.28	6.67(2.89–15.36)	1.10(0.48–2.49)	1.00(0.45–2.20)
Owned by large regional/multi-state health system without a health plan	36	17.22	4.23(1.57–11.40)	3.50(1.01–12.12)	0.88(0.34–2.28)
HMO/Payor owned	1	0.48			
Publicly owned	16	7.66	1.13(0.42–3.01)[3]	2.80(0.53–14.62)[3]	0.71(0.19–2.65)[3]
University owned	4	1.91			
Estimated number of adult beds (n=171)					
0	3	1.75	REF	REF	REF
1–250	73	42.69	14.5(5.25–40.09)	2.14(0.61–7.51)	2.24(0.64–7.87)
251–450	39	22.81	18.13(5.38–61.11)	6.64(1.47–29.99)	0.73(0.20–2.76)
>450	56	32.75	6.82(2.95–15.77)	1.33(0.39–4.47)	1.72(0.50–5.90)
Number of oncology physicians (n=210)					
0–6	80	38.10	REF	REF	REF
7–11	45	21.43	0.94(0.44–1.99)	1.19(0.45–3.17)	2.25(0.88–5.75)
12–22	45	21.43	3.70(1.40–9.78)	1.27(0.52–3.09)	2.42(1.03–5.69)
23 and more	40	19.04	4.09(1.45–11.59)	2.33(0.85–6.38)	1.33(0.55–3.22)

[1]The number of practices providing organization characteristics is in the parenthesis: (n=__).

[2]The number of practices with the characteristic is provided in the column.

[3]Odds ratio comparing the combination of HMO/Payor owned and Publicly owned and University owned compared to Independently owned.

Table 3.

Adjusted Odds Ratios of availability of lung cancer screening, radiologist involvement screening service management and screening service designation as an ACR Designated Lung Cancer Screening Center.

	Low dose CT for lung cancer screening onsite available	**Radiologist involvement in service management**	**ACR Designated Lung Cancer Screening Center***
Organizational characteristics	Adjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)
Minority or underserved site under NCORP	0.35(0.13–0.95)		
Primarily a safety-net hospital	3.23(1.02–10.20)		
Affiliated with a designated Critical Access Hospital	3.49(1.11–10.95)	0.37(0.16–0.86)	
Organizational ownership			
Independently owned	REF	REF	
Owned by large regional/multi-state health system with a health plan	2.76(0.99–7.66)	0.98 (0.40–2.43)	
Owned by large regional/multi-state health system without a health plan	2.55 (0.79–8.21)	3.42 (0.92–12.74)	
HMO/Payor owned, Publicly owned and University owned	0.34 (0.08–1.37)	3.08(0.54–17.69)	
Estimated number of adult beds:			
0	REF	REF	
1–250	6.75 (2.40–18.95)	1.37(0.37–5.04)	
251–450	15.49(3.50–68.61)	6.32(1.31–30.51)	
>450	4.43(1.25–15.72)	2.46(0.65–9.30)	
Number of oncology physician			
0–6	REF		
7–11	1.17(0.41–3.36)		
12–22	3.09(0.84–11.35)		
23 or more	6.80(1.57–29.40)		

*No variables are significant.

Table 4.

Correlates of onsite availability of low dose CT (LDCT) for lung cancer screening, radiologist involvement in lung screening service management and service designation as the American College of Radiology Designated Lung Cancer Screening Center: Sub-analyses excluding Puerto Rico.

	Low dose CT for lung cancer screening onsite available	Radiologist involvement in service management	ACR Designated Lung Cancer Screening Center*
Organizational characteristics	Adjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)
Minority or underserved site under NCORP			
Primarily a safety-net hospital	3.26(1.02–10.48)		
Affiliated with a designated Critical Access Hospital	3.31(1.07–10.20)	0.39 (0.18–0.84)	
Organizational ownership			
Independently owned	REF		
Owned by large regional/multi-state health system with a health plan	2.89 (1.05–8.01)		
Owned by large regional/multi-state health system without a health plan	2.41 (0.76–7.68)		
HMO/Payor owned, Publicly owned and University owned	0.31 (0.08–1.28)		
Estimated number of adult beds:			
0	REF		
1–250	6.53 (2.27–18.79)		
251–450	14.81 (3.18–68.94)		
>450	3.49 (1.02–11.89)		
Number of oncology physician			
0–6	REF		
7–11	1.64 (0.54–4.97)		
12–22	3.42 (0.95–12.32)		
23 or more	6.69 (1.59–28.18)		

*No variables are significant.

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